

Forest Land Habitat Management Program

Progress Report

October 1991

WILDLIFE HABITAT
CANADA
HABITAT FAUNIQUE

A cooperative project supported by
the New Brunswick Department of
Natural Resources and Energy, the
Canada / New Brunswick Cooperation
Agreement on Forest Development and
Wildlife Habitat Canada

FOREST LAND HABITAT

MANAGEMENT

IN

NEW BRUNSWICK

PROGRESS REPORT

Fish and Wildlife Branch
Department of Natural Resources and Energy
Fredericton, New Brunswick
E3B 5H1

Submitted to

WILDLIFE HABITAT CANADA

7 October 1991

EXECUTIVE SUMMARY

Forty-eight percent of the forested area of New Brunswick, or approximately three million hectares, is owned by the Crown. Although management objectives for this land are defined by the Crown, license holders (forest companies) are responsible for the planning and implementation of all management activities. Management plans detailing proposed forest activities are submitted to the Department of Natural Resources and Energy (DNRE) every five years.

There is legislated responsibility to maintain sufficient habitat to ensure that no wildlife species are at risk; yet forest management planning for Crown land has not accounted for habitat supplies. Analyses of forest management plans submitted in 1987 indicated that supply of mature and overmature coniferous-dominated forest would be significantly depleted on Crown land within 25-40 years.

Beginning with Forest Management Plans submitted in 1992, management objectives for Crown land will include specified quantities of two mature coniferous forest types: White-tailed Deer Winter Habitat and Mature Coniferous Forest Habitat. Defined objectives are the result of trade-off analyses of projected timber and habitat supplies.

The inclusion of wildlife habitat goals in forest management planning is a new process. Methodology for the process has been developed by the Forest Land Habitat Management Program, in coordination with Timber Management Branch, of DNRE. Components of the process have been the derivation of habitat objectives, the quantitative definition of habitats in both structural and spatial terms, and the addition of habitat functionality to forest projection models.

Mature coniferous forest habitat is defined as that meeting the structural and spatial requirements of habitat for American marten; however, it is expected to meet the habitat requirements of many other species that require similar forest. The definition of this habitat type for the development of 1992 Forest Management Plans is complete. The definition of white-tailed deer winter habitat will be complete in the next few months; some refinements to spatial criteria are still required.

Development of implementation procedures is nearly complete. Two new forest projection models, with both timber and habitat functionality, were developed under contract and have been delivered to the DNRE. All Deer Wintering Area Management Unit boundaries have been defined and referenced on the Department's geographic information computer system. Habitat availability maps for both mature coniferous forest and deer winter habitat are being produced; these will aid Crown licensees with spatial referencing of habitat supplies.

A component of Forest Management Plans is a spatial referencing of harvesting proposed for the first 25-35 years of the plan. Harvest lay-out rules constrain forest opening size and the time delay for harvesting adjacent areas. A new set of constraints that better reflect general wildlife-habitat relationships have been proposed. Analyses of the effects of proposed changes on sustainable timber harvest rates have been undertaken.

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FOREST LAND HABITAT MANAGEMENT IN NEW BRUNSWICK

The goals of New Brunswick's Forest Land Habitat Management Program are to define habitat objectives for Crown land that will accommodate desired wildlife population levels and to integrate habitat objectives into the forest management planning process for Crown land in New Brunswick.

The program is co-sponsored by the New Brunswick Department of Natural Resources and Energy, the Canada/New Brunswick Cooperation Agreement on Forest Development (Economic and Regional Development Agreement) and Wildlife Habitat Canada. This document is the fifth Progress Report submitted to Wildlife Habitat Canada.

INTRODUCTION

Forty-eight percent of the forested area of New Brunswick, or approximately three million hectares, is owned by the Crown. Crown land is divided into ten timber licenses. Management objectives for Crown land are defined by the Crown; license holders (forest companies) are responsible for all aspects of forest management. Management plans detailing proposed forest activities are submitted to the Department of Natural Resources and Energy (DNRE) every five years; the next series of plans will be submitted in 1992.

There is legislated responsibility to maintain sufficient habitat to ensure that no wildlife species are at risk; yet forest management planning for Crown land has not accounted for habitat supplies. Analyses of forest management plans submitted in 1987 indicated that supply of mature and overmature coniferous-dominated forest would be significantly depleted on Crown land within 30-50 years; other maturity classes and other forest types were not predicted to be in short supply.

Beginning with the 1992 forest management plans, management objectives for New Brunswick Crown land will include specified quantities of two mature coniferous forest types: White-tailed Deer Winter Habitat and Mature Coniferous Forest Habitat. Defined objectives for these habitat types are the result of trade-off analyses of projected timber and habitat supplies.

The inclusion of wildlife habitat goals in forest management planning is a new process. Methodology for the process has been developed by the Forest Land Habitat Management Program, in coordination with Timber Management Branch, of DNRE. Development of habitat objectives, quantitative habitat definitions, and implementation procedures for use in development of 1992 Forest Management Plans is nearly complete, and is detailed in this report.

HABITAT RELATIONSHIPS DEFINITION

Management objectives for New Brunswick Crown land include the maintenance of specified quantities of two mature coniferous forest types: White-tailed Deer (Odocoileus virginianus) Winter Habitat and Mature Coniferous Forest Habitat. Mature coniferous forest habitat is defined as that meeting the structural and spatial attributes of habitat for American marten (Martes americana). Marten are dependant on the availability of relatively large patches of old conifer-dominated forest; hence a supply of habitat designed to meet their needs will likely meet the needs of other species associated with the habitat type.

AMERICAN MARTEN

Marten are dependant on the availability of relatively large patches of old conifer-dominated forest; hence a supply of habitat designed to meet their needs will likely meet the needs of other species associated with the habitat type. Of the 119 wildlife species that utilize forest habitats in New Brunswick, 16 are dependant on the availability of mature coniferous forest (see Appendix 1).

Marten habitat has been defined at both the stand and forest levels. The stand level definition is the range of stand structures considered suitable for marten. Stand level variables used for uneven-aged forest management are stem density and mean stem diameter of conifers; those used for even-aged management are coniferous wood volume and development stage. The forest level definition is the required spatial arrangement of suitable stands; variables are size, shape, composition and interconnectedness of habitat patches. General habitat relationships are from the literature and from responses to a questionnaire sent to researchers and managers of marten throughout North America. Quantitative stand level definitions were built through analysis of inventory data for forest strata likely to support marten.

Habitat definitions have been given to Crown land licensees. They are being used to build stratum-specific yield predictions for habitat to allow the incorporation of habitat objectives into the 1992 Forest Management Plans. A description of New Brunswick's forest management planning

process, particularly as it relates to long-term supply of habitat for marten, was sent to questionnaire respondents and to others involved in marten habitat management or research (Appendix 1). Sections of the document describe marten habitat requirements, methods used to derive habitat objectives, models used to project timber and habitat supplies, and habitat definitions used in supply analyses. Contents of the document formed the basis of a platform presentation given at the Symposium on the Biology and Management of Martens and Fishers in Laramie, Wyoming, 29 May-1 June 1991.

A proposal to undertake research on marten habitat is being drafted. The intent is to refine the stand level habitat definition by collecting data on stand structure and use of stands by marten. Basic structural data will be collected with variable radius timber cruise plots. Data on abundance of dead and down woody debris, commonly thought to be important to marten, will be estimated using techniques developed to estimate fuel loading for forest fire danger predictions. Track transects will be used to collect data on stand use by marten.

WHITE-TAILED DEER

White-tailed deer winter habitat has been defined at the stand level; the forest level (spatial) definition is not yet complete. Stand level variables used for uneven-aged forest management are stem density and mean stem diameter of conifers; those used for even-aged management are species composition and stand age.

Data on stand structure and use of stands by deer were collected within known deer wintering areas during the winters of 1990 and 1991; data on site quality and vegetative composition were collected in the same stands during subsequent summers. Stands were grouped based on similarity of structure. Expected and observed deer use values were compared within each stratum. Strata selected by deer are those where observed use was significantly greater than expected use. The structures of these strata were used to generate a structural definition of winter habitat.

A forest stratum under uneven-aged management provides winter habitat whenever it meets both stem density and mean stem diameter criteria. A forest stratum under even-aged management provides habitat if it meets both species composition and age criteria; forest inventory data were used to determine in which forest strata and at what ages the defined structures occurred.

Stand level habitat definitions have been given to Crown land licensees for use in the development of 1992 Forest Management Plans (Appendix 2). A platform presentation of the results of the habitat selection analyses was given at a meeting of the Atlantic Society of Fish and Wildlife Biologists in Antigonish, Nova Scotia, on 20 September 1991.

Data on site quality and vegetative composition of stands used by deer will be analyzed during the coming year. Although results of analyses will not influence habitat definitions used during development of the 1992 Forest Management Plans, they will influence operating level decisions and the development of future plans, the first of which are scheduled for submission in 1997. Documentation of research results, of stand and forest level habitat definitions, and of management strategies for deer winter habitat will be prepared during the coming year.

WILDLIFE RESEARCH PRIORITY

At the autumn 1991 meeting of The New Brunswick Forest Research Advisory Committee (NBFRAC), wildlife habitat was given a high priority ranking for applied research, second only to forest inventory. The Wildlife Technical Committee of NBFRAC will soon review its Framework for Applied Wildlife Research, originally developed in August 1990 (see October 1991 Progress Report). The intent is to generate specific information requirements with respect to habitat, and to propose research to acquire the information.

FOREST OPENING SIZE AND CUT BLOCK ADJACENCY DELAY

Crown land license holders submit Forest Management Plans to the Department of Natural Resources and Energy every five years. Included in each plan is a spatial referencing of harvesting proposed for the first 25-35 years (5-7 5-year periods) of the plan. Forest stands available for harvest during the spatial horizon of the plan are formed into harvest blocks; a block is harvested in a single operation. Current harvest lay-out rules are that blocks cannot exceed 125 ha (125 ha maximum forest opening size) and adjacent blocks cannot be harvested during the same period (1 period cut block adjacency delay).

The October 1990 Progress Report introduced the need to evaluate opening size and adjacency delay rules from a wildlife perspective. The intent was to adapt timber harvesting practices in the regular forest to reflect general wildlife-habitat relationships. The "regular forest" refers to areas not under management directed specifically to supply deer wintering area habitat or other areas designated for specific treatment.

FOREST OPENING SIZE FOR WILDLIFE

On New Brunswick's Crown licenses, clearcut timber harvesting is a primary factor affecting the distribution of forest openings and hence medium to large scale habitat diversity. Forest openings created by clearcut harvesting can be viewed as both early successional habitat patches and as components of future mature habitat patches. The size and arrangement of clearcuts then, are of direct concern to wildlife.

Clearcut harvesting can maintain or enhance wildlife species diversity and population abundance in so far as it contributes to the spatial heterogeneity of habitat types and age classes. However, no single opening size is optimal for all wildlife. Habitat requirements will likely best be achieved by creating a range of opening sizes. The frequency of occurrence of an opening size should be inversely related to its size, i.e., many small and few large openings. This reflects natural patterns of species and population abundance in relation to their home range sizes, and the distributions of stand sizes and disturbance sizes in the forest (Harris

1984, Hunter 1986, 1987). The desired trend is illustrated by the example distribution in Figure 1. The size limits indicated are examples only; values chosen represent the approximate range of desired sizes.

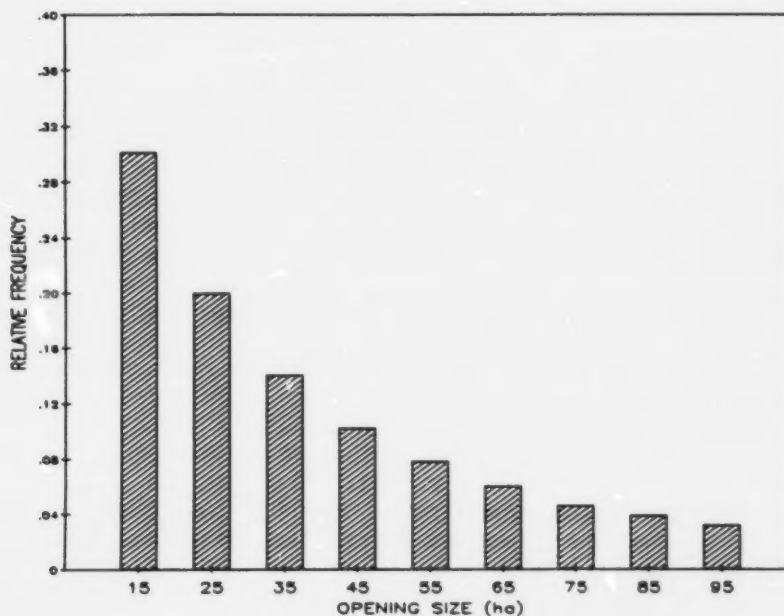


Figure 1. A size frequency distribution of 1000 forest openings between 10 and 100 ha, in a form suited to promoting diversity of forest wildlife. The trend in frequency is the key factor for benefits to wildlife, rather than the absolute size values.

The techniques required to incorporate a frequency distribution of opening sizes into the forest management planning process have yet to be developed. As well, forest composition objectives are not yet defined for early successional stages. A simpler guideline was therefore required for the 1992 Forest Management Plans. Reduction of the current 125 ha maximum cut size was recommended as beneficial, but no single maximum value was supported as a "wildlife guideline". Although any fixed maximum opening size would result in some variation in the size of openings, it would not explicitly direct the supply and spatial arrangement of habitat for wildlife.

LEAVE BLOCK SIZE

Leave blocks are those areas left unharvested between blocks harvested during the same five year period. No change is scheduled to the current rule which states that leave blocks must be of an economically harvestable size. The intent is to avoid leaving unharvested strips between cut blocks and hence to maintain all blocks as viable components of the habitat patch mosaic. An "economically harvestable size" remains discretionary, if not ambiguous, but will hopefully avoid the problems associated with fixed minimums.

ADJACENCY DELAY FOR WILDLIFE

Adjacency delay is the length of time required before clearcut harvesting is allowed adjacent to a recent cutover. The intent is to maintain the integrity of an opening (early successional habitat patch) until such time as adjacent cutting will create a new and distinct opening rather than simply enlarge the existing one. Adjacency delay should therefore reflect the point during stand development at which a structural change meaningful to most wildlife occurs.

Although an acceptable structural difference for wildlife is clearly species-dependent, it has been defined as a vegetative structure (height and density) that would provide hiding cover for deer in summer, and thereby secure access to forage in an adjacent cutover. The height of trees at which hiding cover is first provided was assumed to be 2 metres. Minimum density was assumed to be 3000 stems/ha, based on simulations using the HIDE2 hiding cover model (Lyon 1987).

Licensees are required to conduct a fifth year silviculture survey on all cutovers and plantations. These data were used to assess the height and density achieved on 5 year old clearcuts. Required stem densities were generally achieved by year five; 2 metres of height was not. An increase in adjacency delay from 1 to 2 periods (10 years) was therefore recommended for implementation at the forest management plan level. At the operating plan level, the criterion would be a 2 metre regeneration height, rather than a forced number of years delay. In addition, partially harvested blocks would not be subject to adjacency constraints provided a minimum basal area of 18 m²/ha remains on the site. This level represents current forestry practice designed to maintain stand integrity for multiple-pass harvesting. The capacity of such stands to provide hiding cover is variable, depending on the level of understory remaining, but will be assumed satisfactory in this regard until otherwise determined.

ASSESSMENT OF COSTS TO WOOD SUPPLY

Theoretical Forest

A harvest block scheduling model (BLOCK, Version 1.0, Dallain 1989a, b) was used for preliminary assessment of the effects on wood supply of varying opening size and adjacency delay. It was applied to a theoretical forest of 1600 cells (40 by 40 grid) of 10 ha. Volume yield was constant and equal among cells. The intent was to isolate the influence of blocking constraints on sustainable harvest, independent of the influence of forest structure. Forest structure is the distribution, in terms of abundance and location, of forest stands of different types and ages.

The effects of varying opening size and adjacency delay were tested under two conditions of block availability. Block availability would normally be assigned based on the ages, and therefore volume yields, of constituent stands. For example, blocks composed of old stands would be available now and those composed of young stands would be available at some point in the future. For the first test, individual cells were randomly assigned to 1 of 20 harvest availability classes; classes differed in time when first available for harvest and in duration of availability. For the second case, no availability constraints were applied.

When harvest availability was assigned randomly, no reductions in harvest levels were apparent until opening size fell below 40 ha for adjacency delays of 1 and 2 periods, and below 60 ha for 3 and 4 period delays. For smaller opening sizes, costs to wood supply increased with increasing adjacency delay (Figure 2). When no availability constraints were applied (not illustrated), the trends observed in Figure 2 were repeated at higher sustainable harvest levels.

Observed trends are directly attributable to the limitations imposed on size, position, and timing of harvest blocks and are independent of forest structure. Based on this scenario, the impact of recommended changes to blocking constraints appears to be nil. Applications of the BLOCK model to theoretical forest situations will be useful to further investigate the interaction between forest structure and blocking constraint formulations.

New Brunswick Crown Licenses

In order to assess the influence of real forest structures on the interaction between harvest constraints and sustainable harvest levels, a spatial even-aged forest projection model (GISFORMAN Version 1.1, Baskent 1990) was applied to sample forest areas from Crown Licenses 4 and 7.

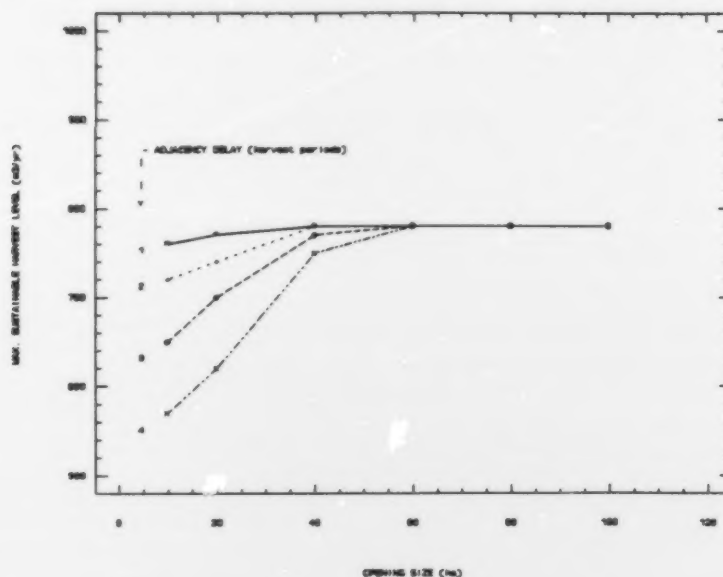


Figure 2. The influence of block size and adjacency delay on maximum sustainable harvest level on a theoretical grid pattern, as predicted by the BLOCK model.

The intent was to measure the wood supply costs to each license of reducing maximum opening size from the current 125 ha, and of increasing adjacency delay from 1 to 2 periods.

The Crown License 4 sample area (111,558 ha) had 63% of its area in softwood dominated forest types. Included were large areas of contiguous mature coniferous forest, as well as some areas that had recently been harvested. Young and immature development stages comprised about 12% of the sample area collectively. Inherent limitations to blocking on this area were assumed minimal, based on the contiguity of large forest areas in similar development stages. Harvest blocks approved for the 1987 Forest Management Plans averaged 100 ha in size.

The Crown License 7 sample area (78,050 ha) included less softwood forest (36%), less mature forest and more forest in a regenerating condition (10%) than License 4. In addition, past cutting practices had resulted in a level of forest fragmentation such that availability of large cut blocks was severely limited. Block size and adjacency constraints were therefore expected to influence wood supply more strongly than for License 4, but general trends were expected to be similar. Harvest blocks approved for the 1987 Forest Management Plans averaged 66 ha in size.

GISFORMAN is not a fully developed model; technical difficulties reduced confidence in simulation results. The principal difficulty was control over harvest block size. Sizes were generally smaller than requested and varied widely about the mean value. Nonetheless, the trends in harvest rate resulting from changes to harvest block size, block adjacency delay, and forest structure are valid.

For License 4, reductions in mean block size to as low as 50 ha, coupled with adjacency delays of up to 3 periods, had only minor effects on maximum sustainable harvest level. Smaller block sizes improved harvest level with delays of 2 periods or less, but this trend was reversed when adjacency was increased to 3 periods. Significant decrease in harvest level occurred only when adjacency delay was increased to 4 periods, independent of block size (Figure 3).

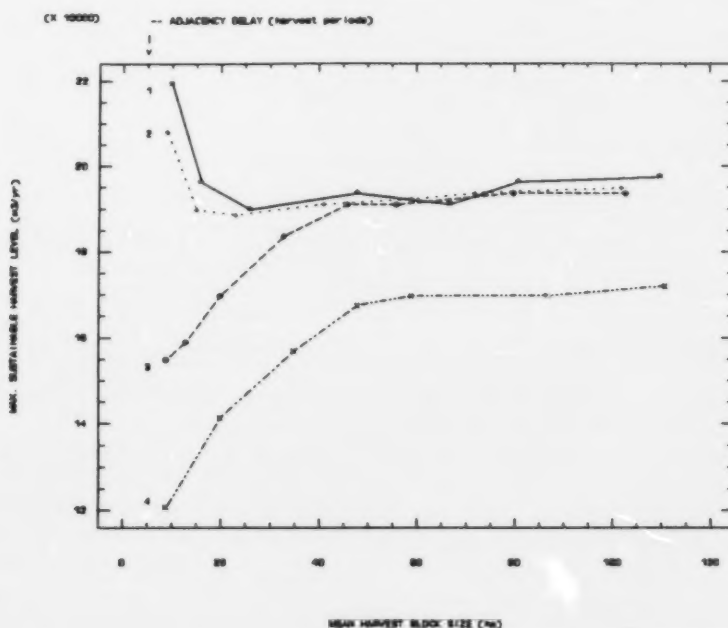


Figure 3. The influence of block size and adjacency delay on maximum sustainable harvest level on a sample of Crown License 4, as predicted by GISFORMAN.

For License 7, mean harvest block sizes over 50 ha were generally not achievable by GISFORMAN (Figure 4). For the range of harvest block sizes observed, relatively high costs to wood supply were associated with all increases in adjacency above 1 period. The interaction between block size and adjacency delay described for License 4 was not evident

on License 7 as similar harvest level trends were observed for all adjacency delay periods. Harvest levels declined as block size decreased.

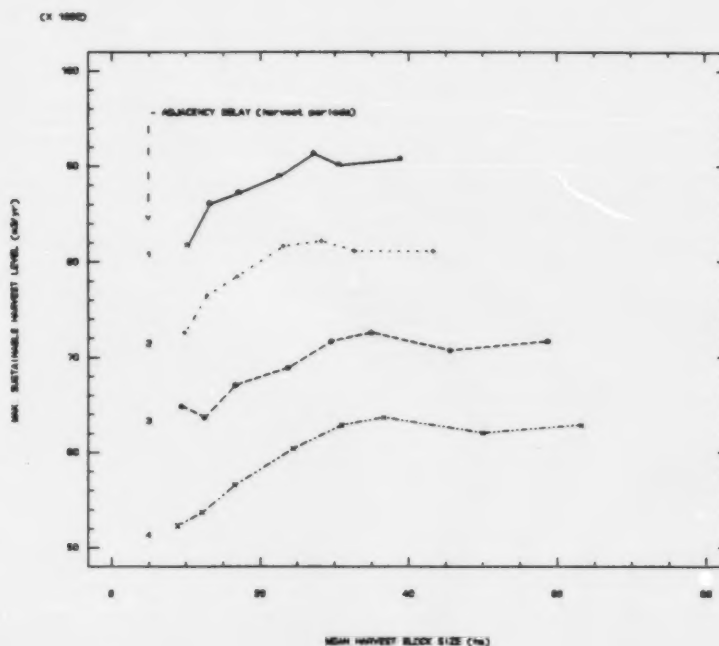


Figure 4. The influence of block size and adjacency delay on maximum sustainable harvest level on a sample of Crown License 7, as predicted by GISFORMAN.

The relationship between constraint formulation and harvest level varied with forest structure. The License 4 forest was relatively contiguous; decreasing opening size and (or) increasing adjacency delay had little effect on the area of land available for harvest in any period and hence did not greatly influence wood supply. The License 7 forest was fragmented such that large harvest blocks were not available. Therefore, reductions in regulated maximum opening size had little influence on size of blocks harvested, and hence on wood supply. However, increasing adjacency delay when opening sizes were small limited the area of land available for harvest in any period and consequently caused a decrease in wood supply.

The results of any spatial harvest simulation apply only to the particular situation; interpretations should be made in light of forest structure, products considered, constraint formulations, and mapping strategies (Clements et al. 1990).

Forest structure was a significant influence on the relationship between constraint formulation and harvest level in trials presented here. The trial areas represent the extremes in levels of forest fragmentation in New Brunswick. Although there is a relatively high level of uncertainty to indicated wood supply costs, the range of costs are likely indicative of the situation on New Brunswick Crown licenses. That this variation exists only emphasizes the difficulty in applying general rules to all situations. In addition, forest composition is dynamic, such that costs associated with blocking guidelines will also change over time. For example, the impact of blocking rules on wood supply will likely be less in regulated forests, with age class structures more balanced than those typical of current New Brunswick forests. For a more detailed discussion of constraint interactions, see Clements et al. (1990).

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FOREST COMPOSITION OBJECTIVES

Forest composition objectives for 1992 Forest Management Plans for Crown land have been established for (1) mature coniferous forest habitat and (2) white-tailed deer winter habitat. Objectives have been reviewed by the Department of Natural Resources and Energy (DNRE) Senior Management Committee. Objectives presented herein are working objectives for the 1992 forest management planning process; they are subject to change due to either biological or economic factors.

MATURE CONIFEROUS FOREST HABITAT

Analyses of 1987 Forest Management Plans for Crown land indicated a significant depletion of mature coniferous forest habitat within 25-40 years (FLHMP Progress Report, March 1990). As a result, management objectives for Crown land now explicitly include maintenance of this habitat type. The intent is to ensure that mature coniferous forest is perpetuated across all Crown forest, so as to provide habitat for all wildlife species that require it.

Abundance objectives for mature coniferous forest habitat were initially derived from the provincial autumn population objective for American marten. The population objective was based on maintaining current marten harvest levels. Population objectives were calculated for each Crown license by prorating the provincial objective to Crown land and then to each license. Prorating was based on relative abundance of conifer-dominated forest. Tentative objectives for abundance of mature coniferous forest habitat were derived from the population objectives for each license.

Wood and habitat supply projections were used to estimate reduction in wood supply resulting from supplying mature coniferous habitat at proposed levels. As a result of these analyses, working habitat objectives were established; these are equal to 10 percent of the conifer-dominated forest on each license. Final cost trade-offs will be made when forest management plans for Crown land are submitted to DNRE. Estimates of supportable autumn populations of marten were calculated from working habitat objectives (Table 1).

Table 1. Objectives for mature coniferous forest habitat (MCFH) and consequent supportable marten populations for New Brunswick Crown land licenses.

License	License Area (ha)	MCFH Objective (ha)	Supportable Marten Population
1	407,900	23,895	430
2	244,350	16,351	295
3	251,300	17,170	308
4	363,600	26,497	478
5	62,10	3,953	70
6	508,100	28,667	516
7	359,200	20,355	368
8	137,650	7,143	130
9	127,90	5,131	92
10	384,000	22,763	411
Totals	2,846,100	171,925	3098

WHITE-TAILED DEER WINTER HABITAT

White-tailed deer winter habitat is a site-specific habitat utilized during severe winter conditions. In the absence of active management, the current forest structure within deer wintering areas (DWA) will cause the supply of habitat to fluctuate widely through time.

Pre-hunt population objectives for white-tailed deer were established by DNRE for each of 27 wildlife management zones (WMZ) (Table 2). Population objectives were based on (1) projected future provincial demand, (2) desired hunter success rates, (3) past and current harvest distribution by WMZ, (4) past and current hunting pressure by WMZ, and (5) estimates of the harvestable proportion of the pre-hunt population.

Winter habitat requirements were calculated for each WMZ (Table 2) using the following equation.

$$\text{Habitat Required} = \frac{\text{Winter Population} \times \text{Yarding Period}}{\text{Habitat Carrying Capacity}}$$

where Habitat Required = area (ha) of winter habitat required to overwinter a deer population, Winter Population = post-

hunt deer population, Yarding Period = number of days deer are confined to winter habitat, and Habitat Carrying Capacity = number of deer-days of use that a hectare of habitat can support. Values for each WMZ are given in table 2.

Table 2. White-tailed deer population objectives and winter habitat requirements for New Brunswick Wildlife Management Zones.

WMZ	Pre-hunt Population Objective	Harvest Objective	Winter Population	Yarding Period (days)	Carrying Capacity (deer-days/ha)	Habitat Requirement (ha)
1	396	59	337	100	18.6	1,811
2	2,360	354	2,006	100	18.6	10,784
3	2,849	285	2,564	110	17.5	16,116
4	3,274	327	2,947	110	17.5	18,524
5	2,925	292	2,633	110	17.5	16,550
6	5,176	776	4,400	100	18.6	23,656
7	5,975	598	5,377	110	17.5	33,798
8	2,298	230	2,068	100	19.2	10,770
9	418	42	376	90	23.4	1,446
10	3,984	598	3,386	80	22.6	11,985
11	10,368	1,555	8,813	100	18.6	47,382
12	6,758	1,014	5,744	110	17.5	36,105
13	5,431	543	4,888	90	18.6	23,652
14	2,507	241	2,256	80	18.6	9,703
15	4,398	660	3,738	80	22.6	13,231
16	9,880	1,482	8,398	90	18.6	40,635
17	7,380	1,107	6,273	90	18.6	30,353
18	7,242	1,086	6,156	70	29.3	14,707
19	2,228	334	1,894	50	48.8	1,941
20	10,082	2,319	7,763	50	37.6	10,323
21	5,014	752	4,262	70	22.6	13,200
22	11,081	2,549	8,532	50	48.8	8,741
23	6,721	1,546	5,175	60	29.9	10,384
24	5,540	1,274	4,266	50	48.8	4,371
25	2,089	480	1,609	40	93.0	692
26	45	10	35	--	--	--
27	545	125	420	--	--	--
All	126,964	20,648	106,316			410,860

Yarding period is the number of days with open snow depths greater than 50 cm, averaged over two consecutive years. Estimates were generated for each WMZ from DNRE winter severity index data and Department of Environment snow depth iso-maps.

Factors considered in estimating habitat carrying capacities were energy requirements of deer, browse biomass production, snow depths, sinking depths of deer, and duration of confinement periods. Estimates of the daily energy requirement of deer were taken from the literature. Browse

biomass was estimated at 78 kg/ha, based on published data from deer wintering areas in balsam fir-spruce forests in Quebec. Snow depth and deer sinking depth data were collected at DNRE winter severity index stations.

White-tailed deer winter habitat requirements were calculated for each Crown license based on proportion of license area in each WMZ (Table 3). Trial habitat supply projections were made on defined deer wintering area management unit (DWAMU) landbases. Results from most licenses indicated that it is unlikely that DWAMU landbases encompass sufficient area to sustain habitat at required levels. The working objective for DWAMU management is therefore to maximize the sustainable supply of deer winter habitat. Objectives will be refined and strategies developed to ensure that they are attainable.

Table 3. White-tailed deer winter habitat requirements and area in deer wintering area management units (DWAMU) for New Brunswick Crown land licenses.

License	Winter Habitat Requirement (ha)	DWAMU Area (ha)
1	22,587	58,838
2	11,607	21,072
3	16,671	9,230
4	19,827	18,263
5	2,619	2,626
6	40,029	36,180
7	19,644	23,974
8	10,159	24,747
9	9,991	17,179
10	21,562	43,615
Totals	174,696	250,724

HABITAT SUPPLY ANALYSIS PROCEDURES

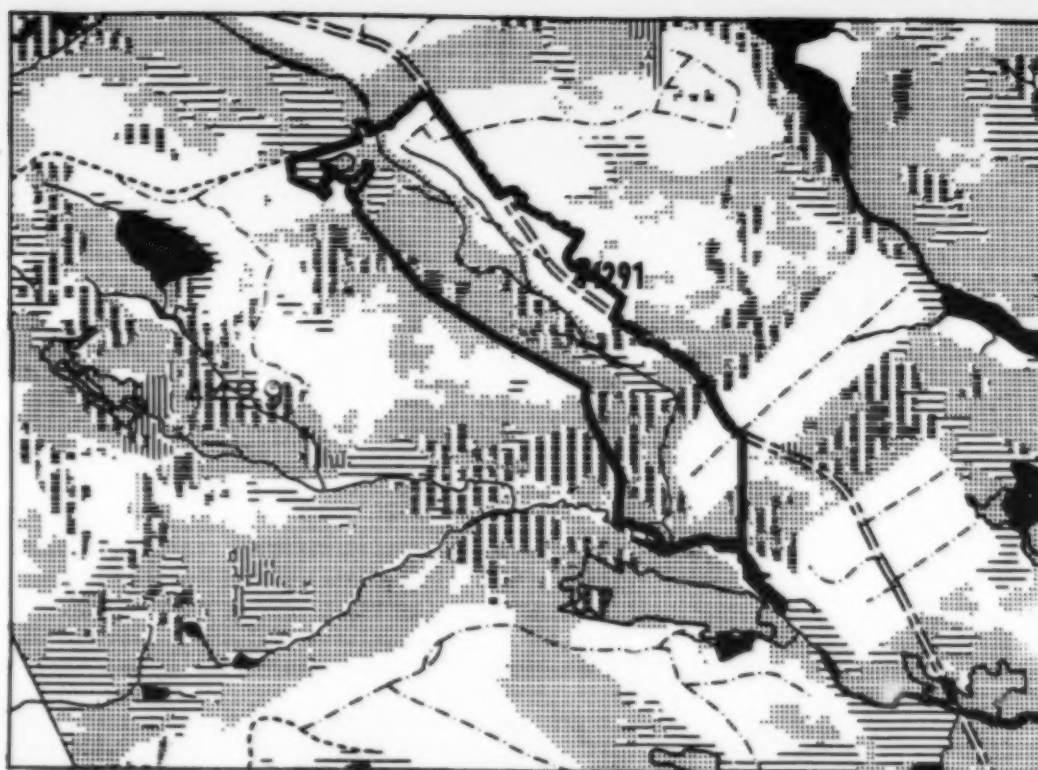
Two new forest level projection models, FORMAN+1 and FORMAN+2, were developed under contract by Vanguard Forest Management Services Ltd., and were delivered on schedule to DNRE in early 1991. In addition to providing improved modelling of current forest management practises, these models incorporate habitat reporting as specified by the Forest Land Habitat Management Program (FLHMP). They will be used by licensees to prepare 1992 Forest Management Plans for Crown land.

All Deer Wintering Area Management Unit boundaries have been defined and entered into the Department's geographic information computer system. A set of 1:50,000 maps indicating the location of all DWAMUs on Crown Land has been produced. Area summaries of DWAMUs have been produced for each license.

As part of Forest Management Plan submissions for Crown land, licensees will be required to indicate the location of spatially-suitable mature coniferous forest habitat blocks. To facilitate habitat blocking, DNRE has offered to provide the licensees with maps showing habitat availability for the time periods covered by the planning horizon. Habitat availability will be plotted for entire licenses at a scale of 1:50,000 in order to provide an overview (Figure 5). Licensees will then determine the areas they want mapped at the larger scale of 1:20,000, which provides the stand-level detail necessary to define habitat blocks. Similar products will be produced for deer winter habitat availability.

A previously existing habitat windows placement program was reprogrammed to accommodate the revised timber yield curve file format used in FORMAN+1. The new program executes more efficiently and provides an option to create output files that can be used for a graphical display of both the timber yield curves and the habitat windows.

As discussed in the October 1990 Progress Report, mature coniferous forest habitat reported by FORMAN+1 does not incorporate the spatial components of the habitat definition. A procedure had been defined to assess whether stands meeting the structural definition of habitat also meet spatial requirements. This procedure is being refined so that the program can be run on a microcomputer by Crown licensees.



SHADE SYMBOLS		OMBRES	
WATER		LAC ou COURS D'EAU	
per. 1 - 7 HABITAT		per. 1 - 7 HABITAT	
per. 1 - 5 HABITAT		per. 1 - 5 HABITAT	
per. 1 - 2 HABITAT		per. 1 - 2 HABITAT	
per. 3 - 7 HABITAT		per. 3 - 7 HABITAT	
per. 6 - 7 HABITAT		per. 6 - 7 HABITAT	
LINE SYMBOLS		SIGNES LINEAIRES	
STREAM		COURS D'EAU	
DEER YARD MANAGEMENT UNIT LEGAL LAND LEASE		ZONE D'AMENAGEMENT POUR L'HABITAT DE CHEVREUIL, ETC.	
OPERATIONALLY INACCESSIBLE		INACCESSIBLE	

Figure 5. Portion of a 1:50,000 map detailing availability of mature coniferous forest habitat.

PLANNING AND ASSESSMENT CAPABILITY

The transfer of management strategy concepts and technical information to Licensee and DNRE users is essential for the successful integration of habitat supply analysis with forest management planning. Feedback from users is required so that management strategies and tools are functional in the operational environment. Over the past year, a number of user workshops and meetings have taken place to facilitate the transfer of information.

SIMULATION MODEL WORKSHOPS

The FORMAN+1 and FORMAN+2 forest projection models are the principal management simulation tools for development of the 1992 Forest Management Plans; they were developed under contract by Vanguard Forest Management Ltd. A workshop on model use was conducted by Vanguard in April 1991. It provided licensee and DNRE regional foresters and biologists with theoretical and technical background on the timber and wildlife habitat functionality of the two models along with hands-on experience in their initialization and use. In-house workshops were subsequently conducted to train program staff and biologists hired under the Canada/New Brunswick Cooperative Agreement On Forest Development.

The ESTABLISHMENT, GROWTH, and STABLE DECLINE models are used for development of timber yield curves for input to FORMAN+1. They were developed at the Université de Moncton, Ecole de sciences forestières, in Edmundston, New Brunswick. A workshop on the use of the models was given in February 1991 by Jim Steinman from the university. Licensee and DNRE forest management planning personnel attended.

REGIONAL HABITAT MANAGEMENT POSITIONS

In July 1991, four habitat management biologists were hired for 24 months under the Canada/New Brunswick Cooperation Agreement on Forest Development (Project 5.5) (See October 1990 Progress Report, Appendix 3). The biologists are assisting DNRE regional biologists, FLHMP staff and Licensees with the integration and assessment of habitat supply analysis into the 1992 Forest Management Plans. Prior to being assigned to the field, the individuals

spent 4 weeks in Fredericton being trained in management strategies and in the use of simulation models being used for management plan development. Individuals were assigned responsibilities for a group of licenses; they work out of four of the five DNRE regional headquarters.

DNRE/LICENSEE MEETINGS AND WORKING GROUPS

In January 1991, meetings of licensee, DNRE Region, Timber Management Branch (TMB) and Forest Land Habitat Management Program (FLHMP) staff were held across the province to review the 1992 forest management planning process. Contact persons from TMB, FLHMP and the appropriate DNRE Region (forestry and wildlife) were assigned to each license. Initial discussions centered around the use of the new stand yield and forest projection models. Meetings are now held every 2-4 weeks to review and discuss progress and to help solve technical problems related to management plan development.

Licensees established a user group in August 1991. The intent was to identify and attempt to solve common technical problems related to forest management planning. At the request of licensees, representatives of DNRE Timber Management Branch and the FLHMP attend meetings.

PUBLIC AWARENESS

Throughout the period covered by this progress report, staff of the Forest Land Habitat Management Program have presented information to the public on habitat management concepts and have promoted habitat management on public lands. Presentations have been made to both consumptive and non-consumptive wildlife user groups and to primary school students.

A poster entitled "Wildlife Habitat For The Future", explaining the objectives of the Forest Land Habitat Management Program, was exhibited at hunter education meetings and during National Forestry Week.

Program staff will continue to increase public awareness of forest habitat management concepts and issues. Recent endorsement of habitat objectives for Crown land by the Department of Natural Resources and Energy has increased the need to promote awareness of the Department's objectives with respect to habitat and timber management.

APPENDICES

APPENDIX 1.

FOREST MANAGEMENT PLANNING FOR SUPPLY
OF MATURE CONIFEROUS FOREST HABITAT
ON NEW BRUNSWICK CROWN LAND

FOREST MANAGEMENT PLANNING FOR SUPPLY
OF MATURE CONIFEROUS FOREST HABITAT
ON NEW BRUNSWICK CROWN LAND

Forest Land Habitat Management Program
Natural Resources and Energy
Fredericton, New Brunswick
Canada

16 September 1991

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INTRODUCTION

Eighty-five percent of the land area of the Province of New Brunswick is forested. The forest area is dominated by conifers; principal species are black spruce (Picea mariana), red spruce (Picea rubens), and balsam fir (Abies balsamea). Forty-eight percent of the forest area, or approximately three million hectares, is owned by the Crown. Crown land is divided into ten timber licenses. Management objectives for Crown land are defined by the Crown; Crown licensees (forest companies) are responsible for all aspects of forest management. Management plans detailing proposed forest activities are submitted to the Department of Natural Resources and Energy every five years.

There is legislated responsibility to maintain sufficient habitat to ensure that no wildlife species are at risk, yet forest management planning for Crown land has not accounted for habitat supplies. Recent analyses of plans submitted in 1987 indicated that supply of mature and overmature (mature) conifer-dominated (coniferous) forest would be significantly depleted on Crown land within 30-50 years; other maturity classes and other forest types were not predicted to be in short supply. One hundred and nineteen wildlife species utilize forest habitats in New Brunswick; 18 of these were identified as being dependant on the availability of mature coniferous forest (see Appendix 1).

Beginning in 1992, objectives for Crown land will include maintenance of specified quantities of 2 mature coniferous forest types: White-tailed Deer Winter Habitat and Mature Coniferous Forest Habitat. Mature coniferous forest habitat is defined as that meeting the structural and spatial attributes of habitat for American marten (Martes americana). Marten are dependant on the availability of relatively large patches of old conifer-dominated forest, hence a supply of habitat designed to meet their needs will likely meet the needs of other species associated with the habitat type. A separate strategy exists for management of winter habitat for white-tailed deer (Odocoileus virginianus) that incorporates their use of traditional wintering areas.

This document describes the forest management planning process for Crown land, particularly as it relates to long-term supply of mature coniferous forest habitat (marten habitat). Described are habitat requirements of marten, methods used to derive habitat objectives, models used to project timber and habitat supplies, and habitat definitions used in supply analyses. Processes and definitions described herein are those being used for the development of 1992 Forest Management Plans.

MARTEN HABITAT REQUIREMENTS

The general ecology of American marten is relatively well understood. In general, its habitat consists of mesic, mature or overmature, coniferous or coniferous-dominated mixedwood forest with a high degree of crown closure and a high incidence of both standing dead trees and windfall (Marshall 1951, de Vos 1952, Francis and Stephenson 1972, Koehler and Hornocker 1977, Soutiere 1979, Bateman 1980, 1982a, Steventon and Major 1982, Strickland and Douglas 1987, Taylor and Abrey 1982, Raine 1983, Spencer et al. 1983, Allen 1984, Wynne and Sherburne 1984, Ritter 1985, Snyder and Bissonette 1987, Thompson 1988, Buskirk et al. 1989). Important life requisites for marten are den sites, escape cover, winter thermal cover, and food.

DEN SITES

Marten use existing cavities in large snags and logs as den sites (Spencer 1981, Martin and Barrett 1983, Allen 1984, Wynne and Sherburne 1984). Den trees in Maine were 40-70 cm in diameter (dbh) (Wynne and Sherburne 1984).

ESCAPE COVER

Marten are vulnerable to predation by larger mammals and raptors (Strickland and Douglas 1987). Old mesic coniferous-dominated forest best provides the structural complexity near the ground that is important for avoidance of predators (S.W. Buskirk, pers. com.). Mesic sites tend to be dominated by shade-tolerant trees (E.g., *Picea*, *Abies*) that retain their lower branches and under which conspecific regeneration persists. Coarse woody debris (stumps, logs, upturned roots, branches) adds to structural complexity; it accumulates more in coniferous stands than in deciduous ones, due to slower decay rates.

WINTER THERMAL COVER

Marten have short fur and a high surface-area-to-volume ratio and are therefore not well adapted to severe cold. In response to low temperatures, marten coordinate the depression of body temperature, the use of protected resting sites and the length of resting periods as means of energy management (Buskirk et al. 1988). Marten preference for subnivean winter resting sites associated with coarse woody debris, such as logs, stumps

and snags, has been documented for Maine (Steventon and Major 1982), south-central Alaska (Buskirk 1984), Sierra Nevada, California (Spencer 1987) and the central Rocky Mountains, Wyoming (Buskirk et al. 1989).

FOOD

The ability of a forest to supply food for marten depends on both abundance and availability of small mammals. Microtine rodents are the most important source of food for marten (Cowan and Mackay 1950, Lensink et al. 1955, Quick 1955, Francis and Stephenson 1972, Bateman 1982a,b, Douglass et al. 1983, Spencer et al. 1983, Zielinski et al. 1983, Buskirk 1984, Hargis and McCullough 1984, Thompson 1988); the most common coniferous forest-dwelling microtine in New Brunswick is the red-backed vole (Clethrionomys gapperi) (Dilworth 1984). Many microtine populations fluctuate periodically in size (e.g., Krebs et al. 1969); food abundance for marten is therefore only partly a function of habitat. Other important food sources for marten are snowshoe hares (Lepus americanus), shrews (Soricidae), deer mice (Peromyscus maniculatus), birds and berries (Bateman 1982b, Thompson 1988).

Marten use leaning trees, fallen branches and upturned roots that protrude from the snow to gain access to prey in subnivean spaces (Marshall 1951, Francis and Stephenson 1972, Steventon and Major 1982, Allen 1984, Hargis and McCullough 1984, Allen 1984). Availability of small mammals in winter may therefore be limited by amount of subnivean access. Access is likely restricted in open areas, young stands, older stands on xeric sites and stands dominated by deciduous species.

HABITAT ABUNDANCE OBJECTIVES

Autumn population objectives for marten were calculated for each Crown license by prorating the provincial objective to Crown land and then to each license. Prorating was based on relative abundance of conifer-dominated forest. Management objectives for mature coniferous forest habitat were derived from the population objectives for each license. Conversion of population objectives to habitat area objectives required that average population density be estimated.

Resident adult marten exclude individuals of the same sex from their home ranges (Hawley and Newby 1957, Francis and Stephenson 1972, Ritter 1985). By assuming that all available habitat in an area is utilized by marten, a maximum density of resident adults can be calculated for each sex (inverse of home range size). Density of marten may vary with time; Thompson and Colgan (1987) reported that home range size increased and density decreased with a reduction in prey density. Home range size estimates for marten from across North America are 2.5-15.6 km² and 0.7-4.3 km² for males and females, respectively (various authors, summarized by Allen et al. 1984). Estimates from Maine are 5.6-9.9 km² and 2.0-2.9 km² for males and females, respectively (Steventon and Major 1982, Wynne and Sherburne 1984). Using the Maine home range sizes, calculated resident densities are 0.44-0.68 marten/km², males and females combined. Density has been estimated directly by determining the number of resident individuals in an area; residents were differentiated from transients by frequency of capture. Density of residents in Glacier National Park, Montana was estimated to fluctuate from 0.19 to 0.69 marten/km² over a 2.5 year period (Hawley and Newby 1957). Francis and Stephenson (1972) estimated a resident density of 0.6 marten/km² for Algonquin Park, Ontario. Soutiere (1979) estimated a resident density of 1.22 marten/km² in what he considered good marten habitat in Maine. Bateman (1982b) considered 1.0 marten/km² a conservative estimate of carrying capacity of good habitat in national parks in the Maritime Provinces. For the purpose of generating habitat objectives, average density of resident marten in New Brunswick was assumed to be 0.5 marten/km².

Field evidence indicated that not all of an individual's home range needs to be in a habitat condition; it was assumed that a block of forest was suitable for marten if 75% of the area within it was in stands with suitable structures. Hence, density of resident marten was expressed as 0.67 marten/km² of suitable forest.

Resident adults have been estimated to be between 32 and 50 percent of the total autumn population (Francis and Stephenson 1972). A residency rate of 40% was assumed for New Brunswick; autumn density, for sexes and all ages combined, therefore, was 1.68 marten/km² of suitable forest.

FOREST MANAGEMENT PLANNING

FOREST MANAGEMENT PLANS

Crown licensees submit forest management plans to the Department of Natural Resources and Energy every five years. The planning horizon is 80 years (16 5-year periods). The planning process makes use of forest projection models that simulate both even-aged (single or multiple pass clearcut) and uneven-aged (selection) forest management systems. Included in the plans are:

1. Yield predictions for merchantable wood volume and wildlife habitat for all current forest strata and as a result of all proposed interventions.
2. Proposed annual harvest rate ($m^3/year$), which must be constant and sustainable over the 80 years.
3. Area (ha) proposed for each type of harvest or silviculture operation each year.
4. Areas of mature coniferous forest habitat and white-tailed deer winter habitat, as consequences of proposed operations, for each 5-year period of the plan. Habitat supplies must remain at or above objectives assigned to the license.
5. Spatial referencing of proposed harvesting and of areas proposed as habitat for the first 25-35 years of the plan. Spatial definitions of habitat must be met.

FOREST INVENTORY

Inventory data used for forest management planning are referenced on a Geographic Information System. Stands were delineated and assigned descriptive attributes from interpretation of 1:12500 true colour aerial photographs. Attributes assigned to each stand include location, area, tree species composition, development stage, crown closure, and site quality. Stands were further assigned, on the basis of species composition, the attribute of forest unit. Forest units are:

SPBF spruce-balsam fir

(SP component includes black, white and red spruce)

BFSP	balsam fir-spruce	
SPIH	spruce-intolerant hardwood	(IH component is primarily aspen and white birch)
PSSP	poor site spruce	(e.g., spruce bog)
IHSP	intolerant hardwood-spruce	
SPTH	spruce-tolerant hardwood	(TH component is primarily sugar maple, red maple, beech and yellow birch)
THSP	tolerant hardwood-spruce	
BFIH	balsam fir-intolerant hardwood	
IHBF	intolerant hardwood-balsam fir	
BFTH	balsam fir-tolerant hardwood	
THBF	tolerant hardwood-balsam fir	
OTSW	other softwood	(OTSW is primarily eastern white cedar)
PINE	pine	(PINE is primarily jack pine)
INHW	intolerant hardwood	
TOHW	tolerant hardwood	
IHTH	intolerant-tolerant hardwood	
THIH	tolerant-intolerant hardwood	

Development stages (DS) are:

Cut (C)	Clearcuts where residuals form less than 20% crown closure and (or) less than 35 m ³ /ha of merchantable wood volume.
Regenerating (R)	Stands where tree height approximates 3 metres.
Young (Y)	Stands that are accumulating wood volume at a rapid rate.

Immature (I)	Stands that are still accumulating volume at a reasonable rate but that are older than Y stands and have not yet reached maturity.
Mature (M)	Stands that are no longer accumulating volume: volume loss due to tree mortality approximately equals volume growth of remaining trees.
Overmature (O)	Stands that are losing volume at a rapid rate: volume loss due to tree mortality exceeds volume growth of remaining trees.

For the purposes of inventory projection, stands are grouped based on similarity in all assigned attributes. A grouping of similar stands is called a forest class (FC). Forest classes are sampled on the ground to estimate distributions, by species, of diameter, height and age and to calculate rates of diameter increment.

EVEN-AGED FOREST MANAGEMENT

Timber Supply Analysis

Parameters of the even-aged model (FORMAN+1, Vanguard Forest Management Services Ltd., 1991) include relationships describing wood volume yield by species for each FC (Figure 1, top). Species-specific yields are combined into product yields as per user requirements, for example, yield of coniferous species combined (Figure 1, bottom). The internal dynamics of the model are the increment of time and the consequent progress of FCs along their respective yield curves. Iteration period is 5 years. Simulated interventions are harvest by single or multiple pass clearcut, planting, juvenile spacing, commercial thinning, or any other for which the user can define a consequent yield. Following intervention, the FC (or a portion of it) is reassigned to a new yield curve, depicting a new pattern of development. Management controls are the levels and types of harvest and silviculture, and the priorities for treatments among FCs. Classes can be prioritized for harvest in order to minimize unharvested volume lost due to decadence, maximize volume harvested, maximize harvest of a specified product, or minimize cost per unit harvested. In the absence of intervention, FCs regenerate naturally (Figure 2).

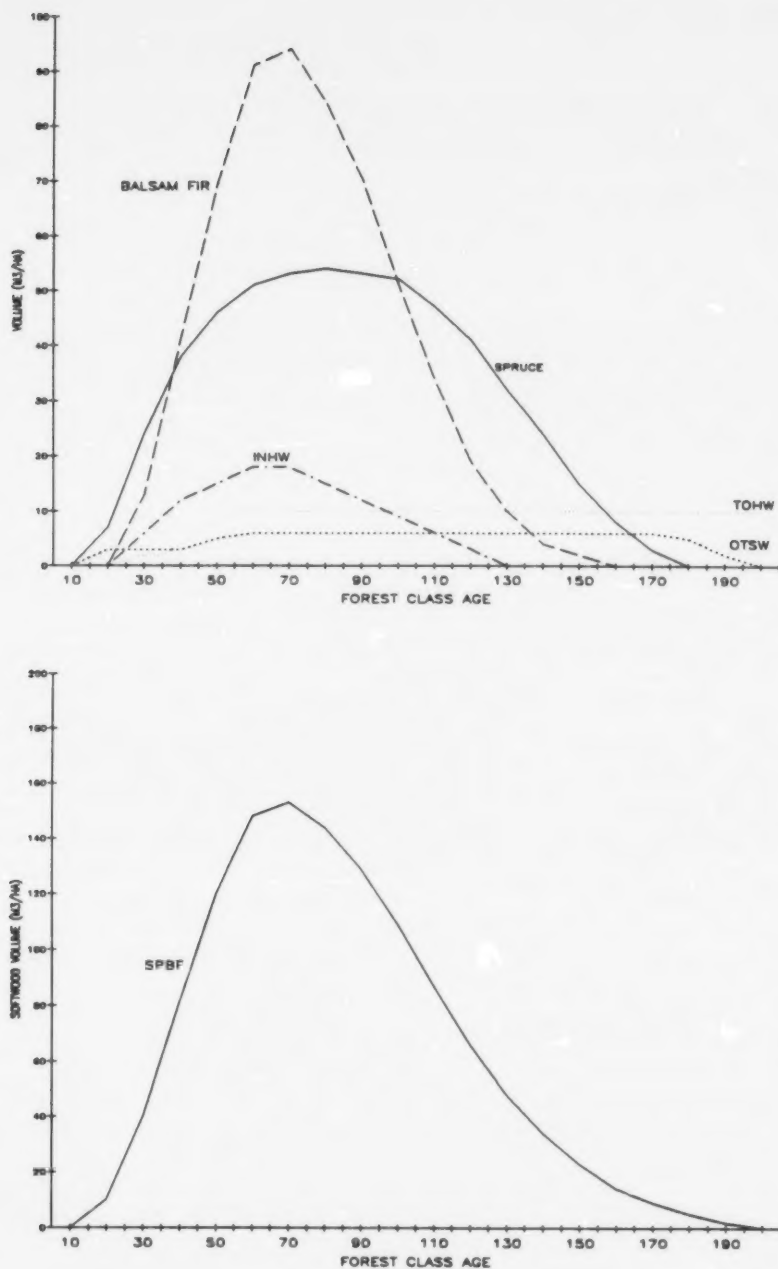


Figure 1. Example of functions describing volume yield by species (top) and volume yield of coniferous species combined (bottom) for a mature, high crown closure, balsam-fir spruce (BFSP) forest class.

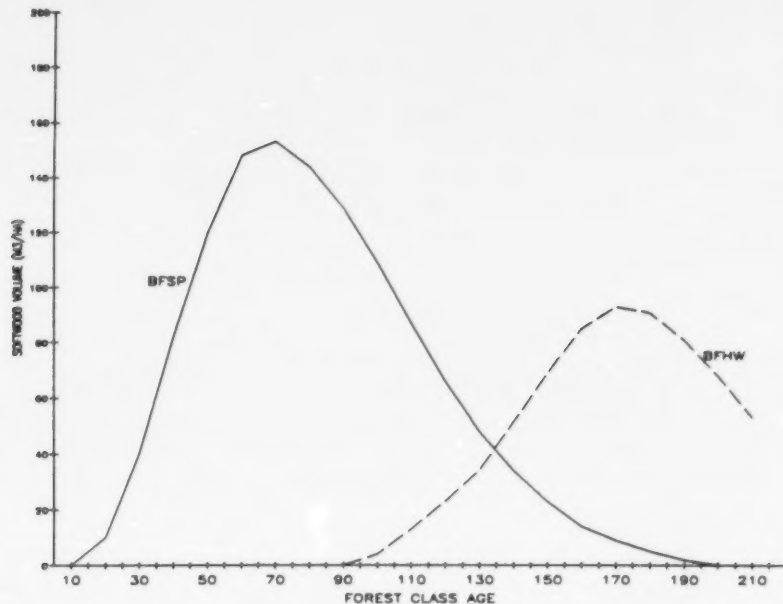


Figure 2. Example of function describing regeneration of a balsam fir-hardwood forest class (BFHW) under a balsam fir-spruce forest class (BFSP) in the absence of intervention.

Habitat Supply Analysis

Information used to build habitat relationships for marten is from the literature and from responses to a questionnaire sent to researchers and managers of American marten throughout North America. I thank A.W. Allen, S.M. Arthur, M.C. Bateman, J.A. Bissonette, S.W. Buskirk, M.T. Chapel, J. Corn, G. Drew, S.E. Henry, G.M. Koehler, E.C. Lofroth, J.D. Steventon, M. Strickland and I.D. Thompson for their contributions. Material presented herein does not necessarily reflect the opinion of any particular contributor.

Marten habitat is defined at both the stand and forest levels. The stand level definition is the range of stand structures that are considered suitable for marten; the forest level definition is the required spatial arrangement of suitable stands. Stand level habitat definitions are components of FORMAN+1; the area of all stands meeting stand-level habitat criteria (GROSS habitat) is reported for each 5-year iteration.

Stand Level Habitat Definition. Marten habitat consists of mesic, mature or overmature, coniferous or coniferous-dominated mixedwood stands of moderate to high productivity. FCs likely to provide habitat are those with forest unit designations of SPBF, SPTH, SPIH, BFSP, BFTH, BFIH and OTSW. Explicitly, suitable FCs are those with maximum coniferous volume ≥ 80 m³/ha, with the exception of those dominated by pines (forest unit = PINE).

The times over which suitable classes contribute to habitat supply are calculated from the coniferous volume yield curve. For each class, the habitat "window" is from the point on the increase component of the curve where coniferous volume = 85% of maximum coniferous volume (MCV) to the point on the decrease component where coniferous volume = 50 m³/ha. The 85% MCV point is an estimate of when the MATURE development stage begins; the 50 m³/ha point is an estimate of when 30% softwood crown closure remains (Figure 3).

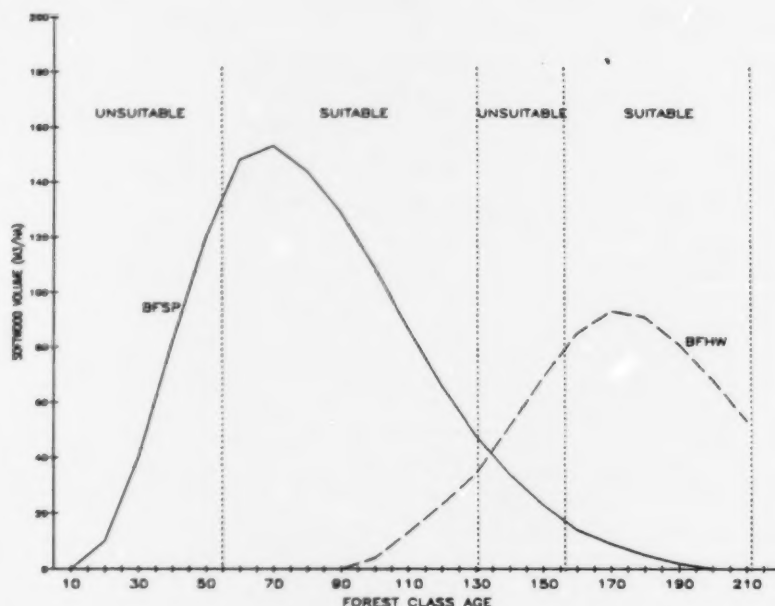


Figure 3. Example of the marten habitat definition for even-aged forest management applied to balsam-fir spruce (BFSP) and balsam fir-hardwood (BFHW) forest classes.

Forest Level Habitat Definition. Stands meeting stand-level habitat criteria (GROSS habitat) contribute towards the tally of NET habitat, and hence towards the habitat objective for the license, if spatial criteria are met. Spatial criteria are that (1) candidate stands are located within habitat blocks (patches)

with a minimum of 375 ha in stands meeting GROSS habitat criteria, (2) a minimum of 75% of the area comprising each block is in stands meeting GROSS habitat criteria, (3) block width normally exceeds 1000 m and always exceeds 500 m at the narrowest point, and (4) blocks are interconnected by travel corridors or riparian buffer strips of at least 30 m in width, in YOUNG or older development stages. It was not possible to predict all potentially suitable arrangements of stands meeting GROSS habitat criteria. Criteria are therefore presented as guidelines; a degree of flexibility will be allowed in their interpretation. Criteria apply equally to stands under uneven-aged management.

UNEVEN-AGED FOREST MANAGEMENT

Timber Supply Analysis

The purpose of the uneven-aged harvest system is the creation and maintenance of multi-aged or all-aged stands through periodic harvest. The principal state variables of the uneven-aged model (FORMAN+2, Vanguard Forest Management Services Ltd., 1991) are a series of stand tables; one is assigned to each forest class that is being considered for uneven-aged management. A stand table is a simple description of stand structure; specifically, it is a tally of number of stems by diameter class by species. Stand tables are used to initialize FORMAN+2. The principal dynamics of the model are that stand table values are dynamic in response to stand development and intervention. The processes controlling stand development are:

1. Diameter growth of single stems. Diameter growth is a function of species, site quality, current diameter class, and current stand basal area. Stand basal area is used as a measure of the level of competition exerted on each stem.
2. Mortality of existing stems. Likelihood of surviving is a function of species, maturity and stand basal area. Stand basal area is used as a measure of (1) degree of suppression exerted by stand structure on development of understory trees, and (2) degree of stability provided to individual older trees.
3. Recruitment of new stems. Rate of recruitment is a function of number and size of overstory stems removed (by harvesting or natural mortality); allocation of recruitment among species is a function of initial species composition of the stand and size of opening.

Management controls are:

1. Minimum basal area at which forest classes become eligible for harvesting.

2. Proportion of total basal area that can be removed at each harvest entry.
3. Minimum period between harvest entries.
4. Minimum and maximum diameters of stems that can be harvested.
5. Harvest priority among stems, based on species, diameter, maturity, or product yield.
6. Harvest priority among forest classes, based on yield of basal area or volume, or on maximizing reentry period.

Habitat Supply Analysis

The FORMAN+2 model projects stand table values through development time, allowing summaries of stand structure to be calculated for each 5-year increment. This provided the opportunity to define wildlife habitat in terms of stand structure, rather than in terms of wood volume yield. Although the use of stand structure to define habitat was intuitively appealing, few data existed from which to construct relationships.

The mature and overmature BFSP and SPBF strata were assumed to be most typical of marten habitat in New Brunswick. The structures occurring within stands in these strata were therefore assumed to be most representative of stand structures suitable for marten. Field data on stand structures from 2540 Forest Development Survey plots located throughout the province were used to define the range of structures occurring within these strata (Figure 4). Structure variables utilized were mean stem diameter (cm) and stem density (stems/ha), for coniferous stems only. Although the range of structures was relatively wide, areas of concentrations of plots were apparent.

The structural definition of marten habitat for uneven-aged management (Figure 4, boxes, and Table 1) was constructed using the following information:

1. An assumption that suitable structures for marten occur in typical, mature or overmature, balsam fir-spruce or spruce-balsam fir stands, i.e., where plots are concentrated in Figure 4.
2. An assumption of avoidance by marten of stands with low mean stem diameters (≤ 12 cm)

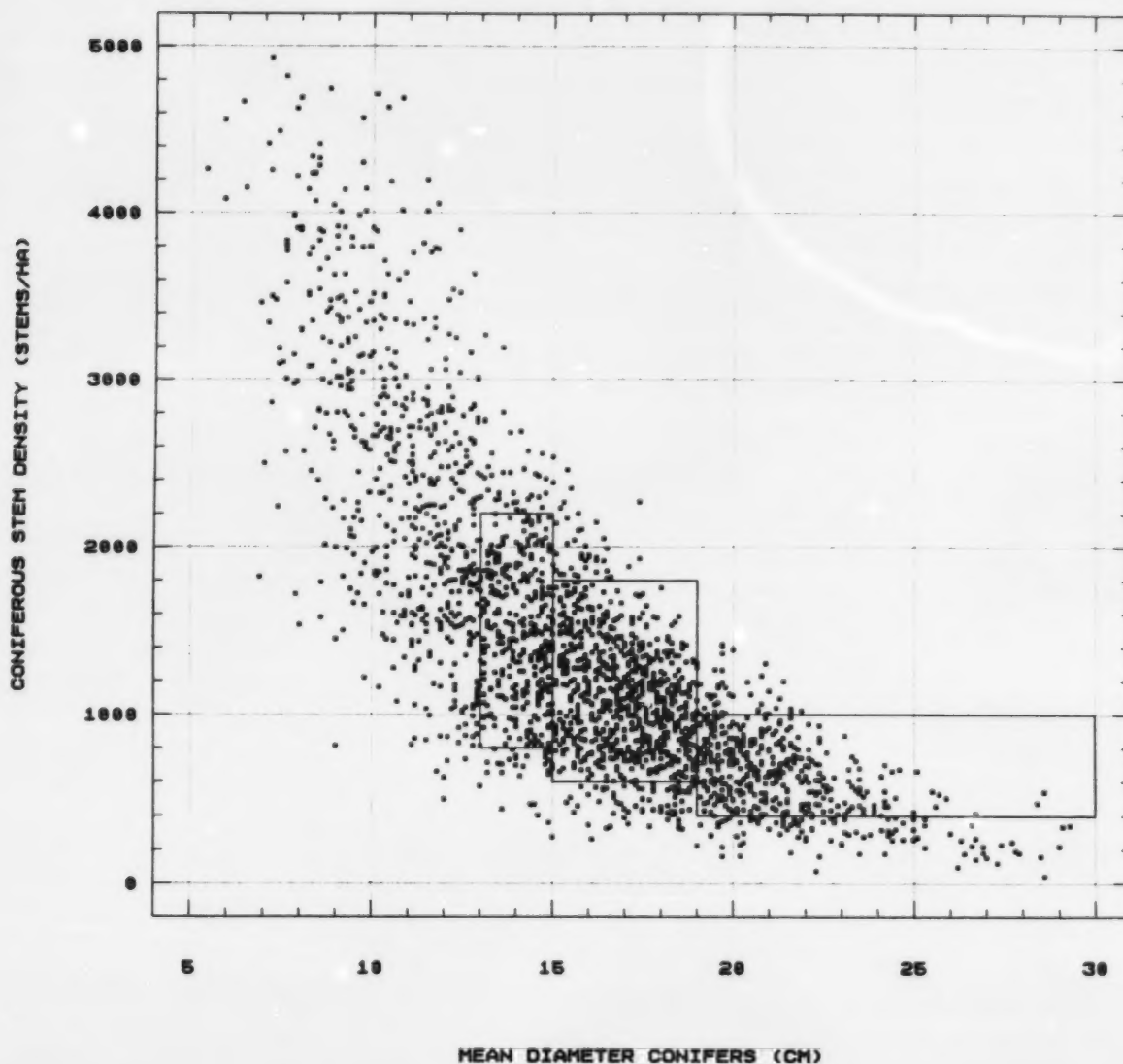


Figure 4. Stem density and mean stem diameter of coniferous stems at 2540 forest development survey plots in mature or overmature, balsam fir-spruce or spruce-balsam fir stands located throughout New Brunswick. The range of structures defining habitat for American marten is within boxes.

3. Data from Maine that suggest that harvest methods that maintain a basal area of 20 m²/ha in pole or larger trees provide adequate habitat for marten (Soutiere 1979).

Table 1. Structural definition of marten habitat for forest classes under uneven-aged management.

WINDOW	MEAN CONIFEROUS DBH (cm)	CONIFEROUS STEMS/HA
A	13 - 15	800 - 2200
B	15 - 19	600 - 1800
C	≥19	400 - 1000

The data indicate that mean stem diameter of conifers rarely exceeds 23 cm. The inclusion of suitable mean diameters ≥24 cm (window C) was to allow for increased growth in managed stands, under the assumption that increasing diameter without reducing stem density would not reduce use by marten.

The habitat implications of most stand level management decisions, such as percent basal area removal, reentry interval, harvest priority among species, and diameter range of stems harvested, can be explored with FORMAN+2. An important component of marten habitat that is not part of FORMAN+2, however, is the availability of standing dead trees and windfall. Therefore, operational specifications for uneven-aged harvest operations that are proposed to create or maintain habitat for marten are that (1) standing dead trees and windfall not be removed, and that (2) sufficient old, decadent (perhaps dying) stems remain in the stand after harvesting to replace them. Ideally, harvesting will occur across the ranges of species, merchantable diameters, and stem conditions in proportion to their occurrences.

BEYOND THE 1992 FOREST MANAGEMENT PLANS

Acceptance of the 1992 Forest Management Plans by the Department of Natural Resources and Energy will constitute a commitment by both licensees and the Crown to the levels and types of activities detailed for the first 5 years of the plans. Implicit is the acceptance of yield predictions of merchantable wood volume and wildlife habitat for current and future forest strata. However, the opportunity exists to refine yield relationships and harvest prescriptions for use in the development of future plans, the first of which are scheduled for submission in 1997.

HABITAT MONITORING

As part of their forest management plan submissions, Crown licensees will spatially reference all areas proposed as mature coniferous forest habitat for the first 25-35 years of the plan. Use of these areas by marten, and by other species identified as being dependant on their availability, can be monitored. As the areas must meet both stand and forest level habitat criteria for the years during which they are proposed, monitoring will serve to test model relationships.

Habitat definitions are relatively wide, allowing licensees considerable leeway to design management strategies that provide habitat with minimal negative impacts on wood supplies. The potential exists that areas proposed as habitat will be a small subset of the range of possible habitat conditions. Monitoring of areas proposed as habitat will determine the extent to which this occurs.

In areas managed under an uneven-aged system, intervention will occur in order to create or maintain desired stand structures. Pre- and post-harvest monitoring of operational blocks will help determine whether prescribed structures can be created by harvest operations.

APPLIED RESEARCH

There is uncertainty in all stand and forest level habitat relationships described in this document. Research can be used to reduce the levels of uncertainty, particularly in the relationships that most influence simulation results. There are information needs at both the stand and forest levels.

Stand Level

Information required at the stand level is the range of structures used by resident marten. Data on variables describing structure can be collected on the ground in association with data on use by marten; they can be analyzed to determine the ranges of structure that are preferred, utilized in proportion to occurrence, or avoided.

Variables describing stand structure differ in their usefulness to landscape-scale, long-term forest management, as a result of the ease with which data can be collected and the reliability with which values can be projected through stand development time. Variables of relatively coarse resolution, such as species composition, development stage, stem density and mean stem diameter, are attributes in the current stand level inventory; values can be projected through time in process-based forest projection models (e.g., FORMAN+2) or can be used to calculate timber volume to determine habitat window locations for models based on volume yield curves (e.g., FORMAN+1). To the extent that coarse variables do not sufficiently explain variability in stand use by marten, data on finer structural variables, such as density and diameters of standing dead stems, volume of coarse woody debris, and degree of structural complexity near the ground, will be needed. Though these features may not be limiting to marten populations in current mature or older conifer-dominated strata, they may potentially be so in future managed stands. These variables are not components of current inventory and hence their values cannot be associated with locations on the ground. Likelihood of occurrence of these features in forest strata can be determined with large-scale inventory, however it may be more cost-effective to incorporate the data collection into future timber inventories.

A much longer term approach, though of perhaps greater validity, is to monitor changes in stand use by marten as structures change over time in a series of permanent sample plots. This would help define when young stands first provide habitat, when old stands cease to provide habitat, and when peak values for habitat occur.

A parallel approach is to manipulate stand structure by partial harvest. Comparison of pre- and post-operation stand structures and intensities of use by marten will help identify the range of conditions that are suitable for marten. There is also potential to explore use by marten of stand structures that do not occur naturally. The intent is not to determine the effect of the harvest operation on use, but rather the effect of the resulting change in structure. Post-operation monitoring would therefore not be undertaken until logging slash has settled and regeneration has occurred in new openings.

Forest Level

Information needs at the forest level are habitat area required per individual marten, and spatial criteria for suitable habitat patches.

Information on home range sizes of male and female residents and on proportions of each sex that are resident can yield estimates of density; these, in turn, yield an estimate of the area required per individual. Data collection requires monitoring of individual marten, most likely with use of a radio telemetry system. Area requirements are used to calculate management objectives for habitat as functions of population objectives.

Information on the minimum contiguous area of habitat that is required for it to be utilized (minimum patch size), on the range of suitable patch shapes, on the influence of inter-patch distance on patch use, and on the requirements for forested travel corridors is required for planning the location and size of forest harvest operations. These parameters are difficult to quantify, as many factors can affect whether a patch is occupied or a travel corridor is utilized. Some control of extraneous variables can be gained by using clear-cut harvesting to create patches and corridors of various sizes and shapes.

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APPENDIX 1 (to Appendix 1)

ASSOCIATION OF NEW BRUNSWICK WILDLIFE SPECIES
WITH MATURE CONIFEROUS FOREST HABITAT

ASSOCIATION OF NEW BRUNSWICK WILDLIFE SPECIES
WITH MATURE CONIFEROUS FOREST HABITAT

SPECIES WITH DEPENDANCE ON AVAILABILITY OF HABITAT TYPE

Mammals

American marten
white-tailed deer
red squirrel
northern flying squirrel

Martes americana
Odocoileus virginianus
Tamiasciurus hudsonicus
Glaucomys sabrinus

Birds

Cape May warbler
red crossbill
white-winged crossbill
red-breasted nuthatch
three-toed woodpecker
black-backed woodpecker
bay-breasted warbler
pine siskin
boreal chickadee
golden-crowned kinglet
ruby-crowned kinglet
pine grosbeak

Dendroica tigrina
Loxia curvirostra
Loxia leucoptera
Sitta canadensis
Picoides tridactylus
Picoides arcticus
Dendroica castanea
Carduelis pinus
Parus hudsonicus
Regulus satrapa
Regulus calendula
Pinicola enucleator

SPECIES WITH STRONG PREFERENCE FOR HABITAT TYPE

Birds

solitary vireo
gray jay
northern parula warbler
blackburnian warbler
pileated woodpecker
brown creeper
yellow-rumped warbler
Tennessee warbler
evening grosbeak
sharp-shinned hawk
purple finch
merlin

Vireo solitarius
Perisoreus canadensis
Parula americana
Dendroica fusca
Dryocopus pileatus
Certhia americana
Dendroica coronata
Vermivora perigrina
Coccothraustes vespertinus
Accipiter striatus
Carpodacus purpureus
Falco columbarius

SPECIES WITH PREFERENCE FOR HABITAT TYPE

Mammals

deer mouse
red-backed vole
porcupine

Peromyscus maniculatus
Clethrionomys gapperi
Erithizon dorsatum

Birds

spruce grouse
black-throated green warbler
winter wren
hermit thrush
Swainson's thrush
dark-eyed junco
common raven
northern goshawk
northern saw-whet owl
barred owl
great horned owl
yellow-bellied flycatcher
white-throated sparrow
magnolia warbler
blackpoll warbler

Dendragapus canadensis
Dendroica virens
Troglodytes troglodytes
Catharus guttatus
Catharus ustulatus
Junco hyemalis
Corvus corax
Accipiter gentilis
Aegolius acadicus
Strix varia
Bubo virginianus
Empidonax flaviventris
Zonotrichia albicollis
Dendroica magnolia
Dendroica striata

OTHER SPECIES THAT UTILIZE HABITAT TYPE (NO PREFERENCE)

Mammals

snowshoe hare
moose
beaver
fisher
bobcat
American black bear
red fox
ermine
mink
eastern coyote
river otter
raccoon
eastern chipmunk
lynx
Arctic shrew
masked shrew
smokey shrew
short-tailed shrew
pygmy shrew
northern water shrew
southern bog lemming

Lepus americanus
Alces alces
Castor canadensis
Martes pennanti
Lynx rufus
Ursus americanus
Vulpes vulpes
Mustela erminea
Mustela vison
Canis latrans
Lutra canadensis
Procyon lotor
Tamias striatus
Lynx canadensis
Sorex arcticus
Sorex cinereus
Sorex fumeus
Blarina brevicauda
Sorex hoyi
Sorex palustris
Synaptomys cooperi

red bat
hoary bat
striped skunk
star-nosed mole
woodland jumping mouse

Birds

ruffed grouse
red-eyed vireo
black-capped chickadee
hairy woodpecker
downy woodpecker
eastern wood-peewee
American crow
brown-headed cowbird
northern flicker
ovenbird
American redstart
black and white warbler
black-throated blue warbler
rose-breasted grosbeak
yellow-bellied sapsucker
great crested flycatcher
American robin
common yellowthroat
least flycatcher
ruby-throated hummingbird
veery
olive-sided flycatcher
northern waterthrush
rusty blackbird

Lasiurus borealis
Lasiurus cinereus
Mephites mephites
Condylura cristata
Napaeozapus insignis

Bonasa unbellus
Vireo olivaceus
Parus atricapillus
Picoides villosus
Picoides pubescens
Contopus virens
Corvus brachyrhynchos
Molothrus ater
Colaptes auratus
Seiurus aurocapillus
Setophaga ruticilla
Mniotilta varia
Dendroica caerulescens
Pheucticus ludovicianus
Sphyrapicus varius
Myiarchus crinitus
Turdus migratorius
Geothlypis trichas
Empidonax minimus
Archilochus colubris
Catharus fuscescens
Contopus borealis
Seiurus noveboracensis
Euphagus carolinus

APPENDIX 2.

FOREST MANAGEMENT PLANNING FOR SUPPLY OF
WHITE-TAILED DEER CRITICAL WINTER HABITAT ON CROWN LAND
PART 1

14 August 1991

FOREST MANAGEMENT PLANNING FOR SUPPLY OF
WHITE-TAILED DEER CRITICAL WINTER HABITAT ON CROWN LAND

PART 1

Supply of white-tailed deer (Odocoileus virginianus borealis) critical winter habitat will be an indicator of forest performance in the 1992 Forest Management Plans for Crown land. Critical winter habitat provides deer with a moderated temperature and snow regime and an accessible food supply during winter. Information requirements to allow the incorporation of objectives for this habitat type into the management planning process include:

1. Identification of the land base on which the Licensee will manage for deer critical winter habitat.
2. Stand level habitat definitions, which are the ranges of suitable stand structures for deer critical winter habitat under both even- and uneven-aged management systems.
3. Submission requirements for the non-spatial management strategy phase of the management plan.
4. Forest level habitat definition, which is the required spatial configuration of suitable stands.
5. Submission requirements for the geographic lay-out phase of the management plan.

Information outlined in points 1, 2 and 3 are provided in this document. Information outlined in points 4 and 5 will be provided in a separate document as soon as possible.

DEER WINTERING AREA LAND BASE

A set of 1:50 000 GIS maps showing the locations of deer wintering area management units (DWAMU) have been distributed to DNRE Regions and Licensees. These areas represent the land base on which the primary management objective will be to supply deer critical winter habitat. A data file (License Restrict File) has been sent to each Licensee and DNRE Region containing the stands and stand area located within DWAMUs. Each DWAMU is identified by a 5 digit number.

STAND LEVEL DEER CRITICAL WINTER HABITAT DEFINITION

Deer critical winter habitat consists of mesic, mature to overmature softwood or softwood dominated mixedwood forest of moderate to high productivity with moderate to high softwood crown closure. It is frequently located in proximity to watercourses. The habitat type has been quantitatively defined to allow estimation of habitat supplies using the FORMAN+1 and FORMAN+2 forest projection models.

Uneven-Aged Forest Management (FORMAN+2)

Data on stand structure, site quality and use of stands by deer were collected within known deer wintering areas. The data were used to generate a structural definition of critical deer winter habitat. Structural variables used to define habitat are softwood stem density and mean softwood diameter; species contributing are wS, rS, bS, bF, eC, eH, wP, rP and jP. A forest class provides deer critical winter habitat for a given period if it meets structural criteria for one of three habitat windows (A, B, or C, Table 1). Habitat definitions are incorporated into FORMAN+2 in the species group file.

Table 1. Structural definition of deer critical winter habitat for forest classes under uneven-aged management.

WINDOW	MEAN SOFTWOOD DBH (cm)	SOFTWOOD STEMS/HA	SITE GROUPS
A	17 - 20	700 - 1800	ALL
B	20 - 24	500 - 1400	ALL
C	≥24	350 - 1000	ALL

Even-Aged Forest Management (FORMAN+1)

For the purpose of even-aged forest management, critical winter habitat has been defined as a time window on selected timber curve sets. Forest Development Survey data and similar data collected in deer wintering areas were analyzed to determine which forest strata, and over what time periods, the structural habitat definition was met (Table 2). Habitat definitions are incorporated into FORMAN+1 in a habitat curve set file. The file will be generated for each license by DNRE FWB, using the appropriate timber curve set file as input. Habitat curves will be generated for both pre-treatment (FROM) and post-treatment (TO) timber curves.

Table 2. Definition of deer critical winter habitat for forest classes under even-aged management.

YIELD CURVE-BASED CURVE SET NAME	HABITAT WINDOW (Age)		SITE GROUPS	CROWN CLOSURE GROUPS
	START	END		
SPBF	60	120	ALL	ALL
BFSP	50	90	ALL	ALL
OTSW	90	--	ALL	ALL
SPTH	60	120	ALL	ALL
SPIH	60	120	ALL	ALL
BFTH	50	90	ALL	ALL
BFIH	50	90	ALL	ALL

MANAGEMENT STRATEGY PHASE OF 1992 MANAGEMENT PLANS

A component of the management strategy submissions to DNRE will be non-spatial analyses of deer critical winter habitat supply. These are tallies by 5-year period of the areas of all stands located within DWAMUs meeting the stand-level habitat criteria. Tallies will be reported for the License as a whole and for two component parts: DWAMUs for which individual strategies are submitted, and the aggregate of remaining DWAMUs, treated as one land unit. No first period management intervention will be approved by DNRE for the aggregated DWAMU area. Licensees must show that a wide array of management alternatives have been explored.

APPENDIX 3.

FOREST LAND HABITAT MANAGEMENT
PROGRAM STAFF

FOREST LAND HABITAT MANAGEMENT

PROGRAM STAFF

POSITION	NAME	STATUS
Program Leader (DNRE)	M. Sullivan	Permanent
Habitat Relationships Leader (DNRE)	D. Beaudette	Permanent
Habitat Relationships Biologist (WHC)	J. Niederleitner	Contract
Habitat Relationships Biologist (DNRE)	S. Lusk	Contract
Habitat Coordination Leader (DNRE)	S. Gordon	Permanent
Habitat Coordination Biologist (WHC)	S. Makepeace	Contract
Computer Systems Leader (DNRE)	L. Vietinghoff	Permanent
Computer Systems Specialist (WHC)	P. Ralph	Contract
Habitat Management Biologist (ERDA)	K. Comeau	Contract
Habitat Management Biologist (ERDA)	D. Fillier	Contract
Habitat Management Biologist (ERDA)	L. Gagnon	Contract
Habitat Management Biologist (ERDA)	J. Kennedy	Contract